LIFE CYCLE COSTING AND LOCAL GOVERNMENT PURCHASING

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The bulletin describes the basic concept of life cycle costing as a procurement policy and shows how LCC can help local governments save energy. For more detailed information on LCC procedures, see the publications listed in the bibliography.

Executive Summary

Local governments devote significant portions of their annual budgets for material and equipment procurement. Many procurement practices base purchasing decisions on a bidding process which considers only an initial acquisition cost. Such practices do not reflect the true costs of ownership, since most items purchased by a local government will incur additional operating and maintenance costs during their useful lives.

Life Cycle Costing (LCC) is a purchasing technique which allows an estimation of the full lifetime costs of a piece of equipment prior to making a decision to buy. LCC techniques allow a purchasing manager to consider costs of operation, maintenance and repair, salvage value and the time value of money in addition to the initial acquisition costs. In the face of rapidly increasing energy prices, an ability to estimate these continuing operating costs is valuable when evaluating competing brands of equipment.

This Information Bulletin discusses Life Cycle Costing and its use in local government procurement. The LCC concept, its components and two examples of its application are described. Procedures for the implementation of LCC procedures are discussed by examining an ordinance passed by the city of Portland, Oregon. Several problems and issues related to LCC implementation are summarized and a bibliography for further reference is included.

Local government managers should share this Information Bulletin with procurement officers, senior staff responsible for making purchasing decisions and other staff interested in the application of LCC techniques to the procurement process.

Contents

Problem Statement

Purchasing practices in municipal governments have been traditionally built around a "minimum first cost syndrome", recommending purchase of that item with the lowest initial acquisition cost. The initial purchase price, however, is only the first cost incurred during the ownership of an item, whether that item is a typewriter, a vehicle or an office building. Other continuing costs of ownership, often overlooked at the time a procurement decision is made, include operating and energy costs, costs of repair and maintenance and salvage value or disposal costs at the end of the item's useful life. A realistic appraisal of an item's real costs of ownership (its Life Cycle Cost) must include these continuing costs in addition to the initial purchase price.

The implementation of Life Cycle Costing (LCC) analyses within local government has encountered several major barriers. Three primary barriers to implementation are the alteration of traditional "first cost" purchasing traditions, the building of staff expertise, and differences in procedures for application. Each of these three difficulties are discussed briefly below:

- <u>Traditional Purchasing Practices</u>

  Traditional "first cost" purchasing practices have a long-standing tradition of use in local governments. There is often a legal basis for this practice with many State purchasing statutes requiring contracts to be let to the lowest initial cost bidder. Several State courts, on the other hand, have allowed contract awards to higher bidders when better quality goods or services have been documented. Recognizing the value of LCC, some States have begun steps to alter this tradition to allow LCC procedures in local governments (examples of legislation from the States of Florida and Washington are included later in this Information Bulletin).

- <u>Staff Expertise</u>

  The expertise to perform LCC analyses often is not available within the staff of a local government purchasing office. Equitable administration of the LCC process may require the definition of detailed performance specifications and the fair evaluation of how well a bidder can meet the stated specifications.

Analytical judgments must often be based on such difficult assumptions as the future cost of energy or the efficiency of a new, relatively untested heating system. In dealing with such "soft" numbers, a substantial level of staff expertise may be required to assure confidence in a final recommendation.

- Procedures for Application

  LCC analysis procedures are not universally applicable to all purchased items and the applied procedures may differ even among those items suitable for LCC analysis. Decisions made for the purchase of short life or disposable items, such as paper or other office supplies, may be realistically based on a conventional lowest initial cost bidding procedure. Analysis techniques applied to the purchase of longer life capital items may vary in sophistication dependent on the total cost of the item, its components and the assumed period of its useful life. Estimates of maintenance costs, for example, are much more important in selecting the heating system for a new building than in the choice among alternative vendors for typewriters.

Life Cycle Costing techniques, correctly developed and applied, can assist a local government procurement officer improve the cost-effectiveness of his purchasing decisions. Overcoming the barriers of conventional purchasing practice, building staff expertise and selecting proper procedures for the application of LCC analyses, however, require a good understanding of LCC concepts and application techniques.

This Information Bulletin is designed to provide an overview of the LCC process, its basic concept, benefits and drawbacks. Readers interested in further detail on application techniques and alternate procedures would be well advised to review one or more of the more detailed publications listed in the Bibliography.

Concept and Application

OVERVIEW

Life Cycle Costing (LCC) is a term describing a number of procurement analysis techniques that take into account, as much as possible, the total or cumulative costs incurred in the ownership of an item. Such considerations necessarily include energy consumption, which constitutes a growing portion of ownership costs as energy prices continue to rise.

All factors affecting the cost of owning and operating a piece of equipment should be considered in the application of LCC analyses. These factors include estimated costs of preventive maintenance and repairs, operation costs (energy, labor and materials), length of useful life, and resale or salvage value. Products which are used over a period of time and which have a resale value at the end of their normal period of use, for example, cannot be accurately compared solely on the basis of initial cost. A machine with a low initial cost may have such a short life, depreciate so rapidly, and cost so much to repair that it is actually more expensive to own and operate than a machine with a higher initial cost and a longer useful life. Unless these factors are considered in procurement analyses for competing products, a municipality may not receive the best value for its money.

GENERAL DESCRIPTION

LCC analyses have a long history of use for economic analyses in the engineering and other professional disciplines as a method for estimating the real life-time costs of owning and operating a piece of equipment. LCC procedures add two major components to traditional "first cost" purchasing analyses:

- Operating and Maintenance Costs
- Present Value of an Investment

Operating and Maintenance Costs

All equipment costs money to operate as well as to purchase. Operational costs may be incurred in the form of energy and materials costs, maintenance, storage, labor and management. For a piece of equipment or other purchased item with a short useful life, operating costs may be relatively small in comparison to an initial purchase cost. For some items

with longer anticipated useful lives, operating costs over a period of years may be substantially more than the initial purchase price. Analysts applying LCC procedures should emphasize a detailed analysis of operating costs for longer life items, with less detail required for those items with short useful lives.

Present Value of an Investment

A given amount of money today is generally more valuable than the same amount of money at some future date. As an example, with an assumed rate of ... interest at 10% per year, $50 one year from now has a "Present Value" of only $45.45 ($50 ÷ 1.10). Accounting for the Present Value of an investment is essential in the realistic comparison of the cost-effectiveness for the timing and types of possible alternate purchases, especially when an item considered for purchase will have a multi-year useful life. The practice of accounting for the Present Value of an investment is called "Discounting" and is an integral part of the LCC process. Tables with pre-calculated Discount rates (or Present Value Factors) are available for various interest rates and years of the investment life.

APPLICATION TECHNIQUES

There is a rapidly growing body of literature (partially shown in the included Bibliography) which describes in detail alternate procedures for the application of LCC techniques to local government purchasing. While there are a variety of LCC practices and procedures of varying sophistication, the general methods and components of an LCC analysis can be summarized as follows:

- Determine Specifications for a Desired Purchase

  Specifications should state the specific functions desired in a piece of equipment, describing standard features, optimal maintenance intervals, energy requirements and other performance characteristics.

- Determine Cost Factors for Analysis

  Primary Cost Factors include acquisition cost, initial logistics cost, recurring costs and salvage value or disposal costs. The acquisition cost is the price of the item. Initial logistics costs are the identifiable, one-time costs incurred for the item, including installation and transportation. Recurring costs are the operation and maintenance costs for the item during its useful life. Salvage value is the estimated worth of the item at the end of its useful life.

- Determine the Useful Life of the Item

  Experience for purchases of similar materials or equipment and vendor warranties can be used to estimate the useful life of a desired purchase. Useful lives may vary considerably among competing types or brands of equipment.

- Determine the Present Value of Each Alternative Investment

  All cost factors should be expressed in terms of Present Value to account for the time value of the investment. Only by stating all costs in terms of Present Value can a true comparison of the cost-effectiveness of alternate investments be made.

- Compare the Present Value of Each Alternative Investment

  Once all cost factors have been adjusted to Present Value, the item with the lowest net Present Value will generally be the most cost-effective purchase.

A sample Worksheet for the determination of Life Cycle Costs is provided in Appendix A, with tables of Present Value Factors for several interest rates. The following sections of this Information Bulletin describe application of the LCC process to the purchase of vehicles and the use of LCC analyses to encourage energy efficient building design.

Applications for Vehicle Procurement

Vehicles provide an excellent example for the use of LCC analysis with its ability to consider the effects of energy efficiency on the lifetime costs of ownership. For purposes of illustration, let us suppose that a fleet manager has made a decision to replace a portion of his automobile fleet. The purchasing office has released specifications for a "standard" passenger vehicle to equalize bid price considerations. These specifications state a desired passenger capacity, wheel base range, minimum engine displacement, tire size, transmission type, and desired extra cost "options". The two responses received to meet these specifications are:

	Vehicle A	Vehicle B
o Purchase Price	$5,000	$6,000
o Fuel Economy	20 mpg	30 mpg

Application of LCC procedures to aid choice of a vehicle requires the identification of relevant Cost Factors, the determination of the anticipated Useful Life of the vehicle and the expression of all costs in terms of Present Value. For this example, relevant Cost Factors include:

o Acquisition Cost	=	Purchase (bid) Price
o Initial Logistics Cost	=	Negligible
o Recurring Costs	=	Fuel and Maintenance
o Salvage Value	=	Trade-in Value

With these basic Cost Factors, the formula for calculating total Life Cycle Cost becomes:

LCC = (Bid Price) + (Fuel Costs/Year + Maintenance Costs/Year)
x (Years of Useful Life) - (Trade-in Value)

Total Costs calculated from this formula must be adjusted for each year of useful life by a Present Value Factor to determine Total Costs expressed in terms of their Present Value. Procedures to determine each factor in the LCC analysis are described below:

- <u>Bid Price</u> -- Stated by the vendor as $5,000 for Vehicle A and $6,000 for Vehicle B.

- <u>Fuel Costs per Year</u> -- Environmental Protection Agency (EPA) fuel consumption figures are 20 mpg for Vehicle A and 30 mpg for Vehicle B. Annual fuel costs are calculated for each vehicle by multiplying the mpg ratings by the projected mileage (15,000 miles per year) times an average cost per gallon for gasoline over the useful life of the vehicles ($1.50 per gallon).

- <u>Maintenance Costs per Year</u> -- Based on the manufacturer's maintenance schedule, actual costs are calculated using records from the municipality's Fleet Management Office which reflect the City's costs for the named procedures. An estimate for both vehicles is $400 per year.

- <u>Years of Useful Life</u> -- Experience in the Fleet Management Office indicates that vehicles of this type should be replaced after about 60,000 miles. With annual mileage projected as 15,000 miles, useful life is estimated as four years.

- <u>Trade-in Value</u> -- By examining the "Blue Book" published by the National Automobile Dealers' Association, vehicles of this type can be expected to have a trade-in value of approximately 40% of their initial price after four years.

- <u>Present Value Factors</u> -- The inflation rate assumed by the municipality is 10% annually. Using tables similar to that shown in Appendix A, Present Value Factors for each year of the vehicle's useful life can be determined. For this example a "discrete" (non-compounded) rate was used.

The Present Value of all costs to be incurred over life of each vehicle is calculated by multiplying total costs incurred in each year times the Present Value Factor for that year, then adding all Present Value Costs per year. These calculations and their results are shown on Table 1. Note that the Present Value Factor applied to the initial purchase price is 1.00, since this cost will be incurred at the beginning of the vehicle's useful life.

Table 1

EXAMPLE APPLICATION OF LCC ANALYSIS FOR VEHICLES

VEHICLE A

	Year 0	Year 1	Year 2	Year 3	Year 4
Cost Factors					
Bid Price	$5,000				
Fuel Cost		$1,125	$1,125	$1,125	$1,125
Maintenance		400	400	400	400
(-)Salvage Value					(-)2,000
Total Cost	$5,000	$1,525	$1,525	$1,525	($475)
Present Value					
Present Value Factor	1.000	0.909	0.826	0.751	0.683
Present Value	$5,000	$1,386	$1,260	$1,145	($324)
Present Value of Total Costs	$8,467				

VEHICLE B

	Year 0	Year 1	Year 2	Year 3	Year 4
Cost Factors					
Bid Price	$6,000				
Fuel Cost		$750	$750	$750	$750
Maintenance		400	400	400	400
(-)Salvage Value					(-)2,400
Total Cost	$6,000	$1,150	$1,150	$1,150	($1,250)
Present Value					
Present Value Factor	1.000	0.909	0.826	0.751	0.683
Present Value	$6,000	$1,045	$950	$864	($854)
Present Value of Total Costs	$8,005				

Results of this sample application demonstrate that, in this case, the vehicle with the higher initial purchase price will be more cost-effective over its period of useful life. Total savings, adjusted to Present Value, are estimated as $462 per vehicle for an equivalent annual cost savings averaging $116 per year over the four years of useful life. The sole component in this saving is the greater fuel efficiency of Vehicle B.

Application to New Building Design

Government buildings are often designed before bids for construction contracts are solicited. For this reason, LCC analysis of a new building must usually occur during the structure's initial design stage. Additionally, since a building has many interrelated components which act together to affect energy use performance, the application of LCC procedures to aid energy efficient construction is much more complex than the relatively simple example given above for vehicles.

In many cases, the use of LCC procedures for a building must be applied on a component-by-component basis. Considering, for example, several alternate systems for Heating, Ventilating and Air Conditioning (HVAC), Cost Factors to be included in the analysis may include:

o Acquisition Cost	=	Purchase Price
o Initial Logistics Cost	=	Installation and Transportation
o Recurring Costs	=	Maintenance and Repair; Fuel and Energy
o Salvage Value	=	Value of various parts and equipment which may be repaired and sold

With these primary Cost Factors, the formula for LCC analysis of alternative HVAC systems can be summarized as:

LCC = (Purchase Price) + (Initial Logistics Cost) + (Annual Costs for Maintenance and Repair + Annual Costs for Fuel and Energy) x (Years of Useful Life) - (Salvage Value)

Again, all costs must be expressed in terms of Present Value to assure that realistic measures of cost-effectiveness can be made.

Florida and Washington were the first states to respond to the need for evaluation of new buildings for energy efficiency during the design stage. Both States passed legislation requiring the state agency responsible for constructing a building to include Life Cycle Cost analysis in the design phase. (These laws are summarized in Appendix B.) Under these laws, the LCC analysis performs a strong advisory function. The Washington law requires a "comparison of three or more energy system alternatives", but makes no specific reference to LCC analysis as the final mechanism for selection of the energy system design.

A memorandum from the Department of General Administration (DGA) of the State of Washington sheds some additional light on the use of LCC analyses in the design selection process. This memorandum requires that the design selection process include:

- Summary of owning and operating costs on a Present Worth (Value) basis;
- Summary of owning and operation costs on an Equivalent Annual Cost basis;
- A payback or break-even cost-benefit comparison of three (3) mechanical system alternatives; and
- A summary outline of the rationale for selection of the final alternatives, architectural variables and mechanical systems recommended.

LCC analysis in Washington is thus a second line of defense against energy waste. First, the building is designed according to standards promulgated by the DGA. Second, LCC analyses can determine which design alternatives provide the best ratio of energy efficiency to acquisition or construction costs. This approach is sound, provided the initial energy conservation design standards are sound.

Implementation of the Florida law appears more complicated at first, but is essentially the same. This law requires at least two alternative energy consumption system designs. Alternative system designs must stay within the energy budgets established by the Florida Department of General Services (DGS) for that specific type of building. The alternative designs are compared using the Florida Life Cycle Evaluation Technique (FLEET) computer program, which yields both energy performance indices and life cycle cost analyses. Each alternative must reduce energy consumption below the level set by DGS. LCC analysis selects the alternative which reduces energy consumption at the greatest total cost reduction. Since numerical energy efficiency standards tend to stagnate over a period of years, the Florida approach presents an innovative strategy for overcoming this problem.

SUMMARY

The previous discussions have demonstrated how Life Cycle Costing techniques can be applied to competitive bidding and how two States are using the techniques to aid energy efficiency in new building construction. These demonstrations were designed to show the potential for LCC procedures to aid energy cost reduction through the purchasing process, not to provide a full, comprehensive instruction manual detailing all possible applications of LCC analysis. Readers desiring a more complete discussion of the LCC process should review and obtain one or more of the reference materials listed in the Bibliography to this Information Bulletin.

The examples of LCC analysis given in this Bulletin were designed to provide simple illustrations of the potential benefits of the technique and

the general procedures for its application. As such, the examples did not treat all factors you may wish to consider in your use of LCC analysis. Some additional considerations include:

- Productivity

  The objective of LCC is to guide the purchase of materials or equipment which will provide the best performance for the lowest total cost of ownership. Ease of operation, use or work accomplishment are important variables in determining total cost and should be included in the LCC application even though their quantification may be difficult.

- Effects of Inflation

  Recurring costs for maintenance and fuel were stated as constant annual costs in the example of LCC application to vehicle purchase. These costs will usually increase during the useful life of the vehicle and should be more realistically estimated in actual applications.

- Need for Present Value Calculations

  Accounting for the time value of money will generally become more significant as the term or useful life of an investment increases. Present Value calculations were included in the example application to vehicle purchase merely to illustrate use of the "discounting" practice. As a "rule of thumb", Present Value calculations will be necessary only for those materials or equipment with useful lives of ten years or more.

- Abbreviated Applications

  LCC procedures, even without the inclusion of productivity, inflation and Present Value considerations, should provide a better estimate of the real costs of ownership than do simple, "first cost" comparisons. You may wish to try LCC using the sample worksheets contained in Appendix A to judge the best methods for meeting your particular needs.

Life Cycle Costing techniques can aid the cost-effectiveness of purchasing decisions. This benefit, however, cannot be achieved without cost. LCC systems can increase administrative expenses, necessitate the keeping of detailed maintenance records, and reduce the flexibility in both the choice of uses to which equipment may be put and the maintenance procedures which may be employed.

Despite these increased costs, purchasing agents in growing numbers have become convinced of the overall advantages of total-cost LCC bidding. Thus, cities including Chicago, Amarillo, Winston-Salem, Los Angeles and Phoenix, as well as the States of Florida, Washington and California, have begun use of bidding procedures incorporating elements of Life Cycle Costing.

Policy Implementation

OVERVIEW

While the value of Life Cycle Cost analyses as an aid to cost-effective local government procurement is generally recognized, problems associated with actual implementation may be substantial. Local government implementation of LCC techniques will be examined by briefly reviewing a resolution adopted by the city of Portland, Oregon. This review is followed by a more general discussion of three major issues which should be addressed by any municipality considering the use of LCC procedures.

IMPLEMENTATION IN PORTLAND, OREGON

Resolution Number 31957 was adopted by the Portland City Council in September, 1977, to facilitate the use of Life Cycle Costing techniques when making procurement decisions (see Appendix B).

The Portland ordinance requires the City Purchasing Agent, upon instruction from City Council, to draw up rules, regulations and procedures to encourage the use of LCC. It is the responsibility of the Purchasing Agent to provide guidelines to delineate those items subject to procurement on the basis of an LCC analysis. For example, LCC may be of little value in the purchase of consumables, such as office supplies, but will clearly be of value in the purchase of any energy intensive equipment or items that vary substantially in terms of energy efficiency.

The Purchasing Agent will also be responsible for the development of guidelines to determine what specific Cost Factors will be considered in the application of LCC analyses. Based on these guidelines, a bidder will be requested to provide information on operating costs, minimum time between equipment failures, time required for equipment repair or parts replacement, fuel consumption characteristics, and any other data pertinent to LCC analysis for an item under consideration.

Finally, the Purchasing Agent must develop guidelines for determining, in a reasonable manner, the estimated useful life of any item subject to procurement. Such estimates need not be exact, but should provide a reasonable approximation of the estimated time from the date of acquisition to the date of replacement or disposal by the City. For items with a multi-year useful life, the Purchasing Agent may need to discount all costs to

Present Value. The discount rate applied for Present Value calculations should be determined by City Council or the City Accounting Office in conjunction with the Purchasing Agent.

Since the implementation of LCC procedures will place additional budget and manpower requirements on the Purchasing Department, the Department was authorized one additional staff member. This person would be charged initially with the development of criteria for LCC application and the definition of specifications and guidelines for use by other Bureaus and Departments within the City.

DISCUSSION OF GENERAL ISSUES

Implementation of a procurement policy similar to Portland's will require that several major issues be addressed. These issues can be considered under three general headings:

- Manpower and Implementation Costs

  LCC requires a more complex analysis process than traditional "first cost" purchasing procedures. Because of this increased complexity, implementation of an LCC policy will almost always entail additional staff time and costs. Hiring of additional staff or the training of existing staff for the application of LCC techniques may be required. In most cases, eventual cost savings resulting from LCC implementation should more than compensate for these additional costs.

- Data Development and Analysis

  Previous sections of this Bulletin discussed the importance of defining what Cost Factors should be included in an LCC analysis. Efforts should be made to define and include all relevant costs and to ensure that cost projections are not speculative. Estimates of vehicle resale values may or may not be considered speculative depending on how accurate past estimates have been. Gasoline consumption rates, on the other hand, can be estimated with relative accuracy when based on EPA's "mpg" ratings. The availability of reliable equipment performance test data can be of substantial assistance in the determination of Cost Factors for inclusion in an LCC analysis. Test data for a variety of equipment is available from manufacturer's associations, the Federal government, and other private sources to confirm or justify the need for Cost Factors included in the analysis.

- Fairness in the Bidding Process

  Fairness among potential bidders requires that Cost Factors for the analysis be clearly defined in the bid invitation. Since costs quoted by a bidder for the four major cost categories previously described (Purchase Price, Logistics Costs, Recurring Costs and Salvage Value) will ultimately determine the winner of a contract, the bid invitation must contain clear,

equitable performance criteria and specifications, to include at least a general description of the evaluation process.

If bid requirements are not fairly defined, the LCC process may be challenged on the basis that it is detrimental to competition, providing undue assistance or hinderance to a given vendor. Conversely, the LCC process, when properly conducted, can facilitate competition by giving a more complete hearing to vendors with more innovative, efficient equipment.

To ensure fair competition, it is important that specifications stated in the bid invitation be "product neutral". Transportation costs, for example, will apply equally to all bidders once a shipment site is specified, regardless of the vendor or brand of equipment. Energy consumption rates and costs will also apply to all energy consuming equipment, regardless of vendor or brand.

Other issues may become apparent during your consideration of LCC implementation. Recognize, in any case, that the adoption of a sound LCC procurement policy may not be a simple process. For successful implementation, a purchasing agent and his staff should be well versed in LCC procedures and practices and should have a strong supporting commitment from the municipality's top management staff.

CONCLUSIONS

Life Cycle Cost analysis procedures are substantially more complex than traditional "first and lowest cost" procurement techniques. This drawback, however, is offset by LCC's ability to furnish better total cost comparisons of alternative purchases than can be provided by the simpler "first cost" techniques.

The need to reduce energy costs can be a major factor in a decision to adopt LCC procurement policies. In past years, energy costs for equipment operation were a relatively unimportant factor in procurement decisions. With the almost certain probability of continuing energy price increases, however, a purchasing officer should consider the effects of energy efficiency in any procurement decision.

LCC provides a tool to aid the reduction of energy costs and use in two primary ways. First, by justifying the acquisition of more energy efficient equipment, a city can realize a direct reduction in energy consumption and costs in its daily service and facility operations. Second, wide-spread adoption of LCC procedures among local governments will encourage manufacturers to design and market increasingly energy efficient equipment. While this latter consideration may be of more significance on a regional or national scale, it is one means for local governments to aid this country's total effort to improve its cumulative energy use efficiency.

Finally, LCC is a wise purchasing technique even without the considera- of its potential to reduce energy costs. Applied, even in an abbreviated form, it may still provide a better rationale for choice among alternative purchases than can be furnished by "first cost" procurement techniques.

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APPENDIX A

Present Value Factors and Sample LCC Worksheet

PRESENT VALUE FACTORS

Discrete Compounding

n	i = 8% Present worth factor To find P given F P|F i,n	i = 9% Present worth factor To find P given F P|F i,n	i = 10% Present worth factor To find P given F P|F i,n
1	0.9259	0.9174	0.9091
2	0.8573	0.8417	0.8264
3	0.7938	0.7722	0.7513
4	0.7350	0.7084	0.6830
5	0.6806	0.6499	0.6209
6	0.6302	0.5963	0.5645
7	0.5835	0.5470	0.5132
8	0.5403	0.5019	0.4665
9	0.5002	0.4604	0.4241
10	0.4632	0.4224	0.3855
11	0.4289	0.3875	0.3505
12	0.3971	0.3555	0.3186
13	0.3677	0.3262	0.2897
14	0.3405	0.2992	0.2633
15	0.3152	0.2745	0.2394
16	0.2919	0.2519	0.2176
17	0.2703	0.2311	0.1976
18	0.2502	0.2120	0.1799
19	0.2317	0.1945	0.1635
20	0.2145	0.1784	0.1486
21	0.1987	0.1637	0.1351
22	0.1839	0.1502	0.1228
23	0.1703	0.1378	0.1117
24	0.1577	0.1264	0.1015
25	0.1460	0.1160	0.0923
26	0.1352	0.1064	0.0839
27	0.1252	0.0976	0.0763
28	0.1159	0.0895	0.0693
29	0.1073	0.0822	0.0630
30	0.0994	0.0754	0.0573
31	0.0920	0.0691	0.0521
32	0.0852	0.0634	0.0474
33	0.0789	0.0582	0.0431
34	0.0730	0.053[illegible]	0.0391
35	0.0676	0.049[illegible]	0.0356
40	0.0460	0.0318	0.0221
45	0.0313	0.0207	0.0137
50	0.0213	0.0134	0.0085
55	0.0145	0.0087	0.0053
60	0.0099	0.0057	0.0033
65	0.0067	0.0037	0.0020
70	0.0046	0.0024	0.0013
75	0.0031	0.0016	0.0008
80	0.0021	0.0010	0.0005
85	0.0014	0.0007	0.0003
90	0.0010	0.0004	0.0002
95	0.0007	0.0003	0.0001
100	0.0005	0.0002	0.0001

n	i = 12% Present worth factor To find P given F P|F i,n
1	0.8929
2	0.7972
3	0.7118
4	0.6355
5	0.5674
6	0.5066
7	0.4523
8	0.4039
9	0.3606
10	0.3220
11	0.2875
12	0.2567
13	0.2292
14	0.2046
15	0.1827
16	0.1631
17	0.1456
18	0.1300
19	0.1161
20	0.1037
21	0.0926
22	0.0826
23	0.0738
24	0.0659
25	0.0588
26	0.0525
27	0.0469
28	0.0419
29	0.0374
30	0.0334
31	0.0298
32	0.0266
33	0.0238
34	0.0212
35	0.0189
40	0.0107
45	0.0061
50	0.0035

Source: White, Agee and Case, Principles of Economic Engineering Analysis, John Wiley and Sons, Santa Barbara, 1977, pp. 412 - 428.

SAMPLE WORKSHEET

for

LIFE CYCLE COST ANALYSIS *

Equipment or Material: ______________________________

Useful Life: ________ years

COST FACTORS	Year 0	Year 1	Year 2	Year 3	Year 4
Bid Price					
Initial Logistics					
Maintenance					
Fuel					
Materials					
Labor					
Other					
Disposal Cost					
Subtotal					
(-) Salvage Value					
Total Costs per Year					
PRESENT VALUE					
Present Value Factor (PVF)					
Present Value					
PRESENT VALUE OF TOTAL COSTS					

$$* \ LCC = (\text{Bid Price}) + (\text{Total Costs}_{yr\ 1,\ yr\ 2, \ldots yr\ n}) \times (PVF_{yr\ 1,\ yr\ 2, \ldots yr\ n}) - (\text{Salvage Value}_{yr\ n}) \times (PVF_{yr\ n})$$

APPENDIX B

Examples of State and Local Government Legislation

State of Washington Energy Conservation in Design of Public Facilities

§39.35.010—Legislative Findings

The legislature hereby finds:

(1) That major publicly owned or leased facilities have a significant impact on our state's consumption of energy;

(2) That energy conservation practices adopted for the design, construction, and utilization of such facilities will have a beneficial effect on our overall supply of energy;

(3) That the cost of the energy consumed by such facilities over the life of the facilities shall be considered in addition to the initial cost of constructing facilities; and

(4) That the cost of energy is significant and major facility designs shall be based on the total life-cycle cost, including the initial construction cost, and the cost, over the economic life of a major facility, of the energy consumed, and the operation and maintenance of a major facility as they affect energy consumption. [Added by Laws 1st Ex. Sess. 1975 Ch. 177 §1.]

§39.35.020—Legislative declaration

The legislature declares that it is the public policy of this state to insure that energy conservation practices are employed in the design of major publicly owned or leased facilities. To this end the legislature authorizes and directs that public agencies analyze the cost of energy consumption of each major facility to be planned and constructed or renovated after September 8, 1975. [Added by Laws 1st Ex. Sess. 1975 Ch. 177 §2.]

§39.35.030—Definitions

For the purposes of this chapter the following words and phrases shall have the following meanings unless the context clearly requires otherwise:

(1) "Public agency" means every state office, officer, board, commission, committee, bureau, department, and all political subdivisions of the state.

(2) "Major facility" means any publicly owned or leased building having twenty-five thousand square feet or more of usable floor space.

(3) "Initial cost" means the moneys required for the capital construction or renovation of a major facility.

(4) "Renovation" means additions, alterations, or repairs within any twelve month period which exceed fifty percent of the value of a major facility and which will affect any energy system.

(5) "Economic life" means the projected or anticipated useful life of a major facility as expressed by a term of years.

(6) "Life-cycle cost" means the cost of a major facility including its initial cost, the cost of the energy consumed over its economic life, and the energy consumption related cost of its operation and maintenance.

(7) "Life-cycle cost analysis" includes, but is not limited to, the following elements:

(a) The coordination and positioning of a major facility on its physical site;

(b) The amount and type of fenestration employed in a major facility;

(c) The amount of insulation incorporated into the design of a major facility;

(d) The variable occupancy and operating conditions of a major facility; and

(e) An energy-consumption analysis of a major facility.

(8) "Energy systems" means all utilities, including, but r limited to, heating, air-conditioning, ventilating, lightir and the supplying of domestic hot water.

(9) "Energy-consumption analysis" means the evaluati of all energy systems and components by demand and type energy including the internal energy load imposed on a m jor facility by its occupants, equipment, and componen and the external energy load imposed on a major facility the climatic conditions of its location. An energy consum tion analysis of the operation of energy systems of a ma facility shall include, but not be limited to, the following e ments:

(a) The comparison of three of more system alternativ

(b) The simulation of each system over the entire ran of operation of such facility for a year's operating perio and

(c) The evaluation of energy consumption of compone equipment in each system considering the operation such components at other than full or rated outputs.

The energy-consumption analysis shall be prepared by professional engineer or licensed architect who may u computers or such other methods as are capable of produ ing predictable results. [Added by Laws 1st Ex. Sess. 197 Ch. 177 §3.]

39.35.040—Facility design to include life-cycle co analysis

On and after September 8, 1975 whenever a public agenc determines that any major facility is to be constructed renovated such agency shall cause to be included in th design phase of such construction or renovation a provisic that requires a life-cycle cost analysis to be prepared for suc facility. Such analysis shall be approved by the agency pric to the commencement of actual construction or renovatio A public agency may accept the facility design if the agenc is satisfied that the life-cycle cost analysis provides for a efficient energy system or systems based on the econom life of the major facility. [Added by Laws 1st Ex. Sess. 197 Ch. 177 §4.]

§39.35.900—Severability—1975 1st Ex. Sess. Ch. 177.

If any provision of this act, or its application to any perso or circumstance is held invalid, the remainder of the act, c the application of the provision to other persons or circum stances is not affected. [Added by Laws 1st Ex. Sess. 1975 Ch 177 §5.]

State of Florida
Energy Conservation in Buildings Act

§255.251—Short title

This act shall be cited as the "Florida Energy Conservation in Buildings Act of 1974."

§255.252—Findings and intent

(1) Operating and maintenance expenditures associated with energy equipment and with energy consumed in state-financed and leased buildings represent a significant cost over the life of a building. Energy conserved by appropriate building design not only reduces the demand for energy but also reduces costs for building operation. For example, commercial buildings are estimated to use from 20 to 80 percent more energy than would be required if energy-conserving designs were used. The size, design, orientation, and operability of windows, the ratio of ventilating air to air heated or cooled, the level of lighting consonant with space-use requirements, the handling of occupancy loads, and the ability to zone off areas not requiring equivalent levels of heating or cooling are but a few of the considerations necessary to conserving energy.

(2) Significant efforts are underway by the General Services Administration, the National Bureau of Standards, and others to detail the considerations and practices for energy conservation in buildings. Most important is that energy-efficient designs provide energy savings over the life of the building structure. Conversely, energy-inefficient designs cause excess and wasteful energy use and high costs over that life. With buildings lasting many decades and with energy costs escalating rapidly, it is essential that the costs of operation and maintenance for energy-using equipment be included in all design proposals for state buildings.

(3) In order that such energy efficiency considerations become a function of building design, and also a model for future application in the private sector, it shall be the policy of the state that buildings constructed and financed by the state be designed and constructed in a manner which will minimize the consumption of energy used in the operation and maintenance of such buildings.

§255.253—Definitions

(1) "Division" means the Division of Building Construction and Maintenance of the Department of General Services.

(2) "Facility" means a building or other structure.

(3) "Energy performance index or indices" (EPI) means a number describing the energy requirements at the building boundary of a facility, per square foot of floor space or per cubic foot of occupied volume, as appropriate under defined internal and external ambient conditions over an entire seasonal cycle. As experience develops on the energy performance achieved with state building, the indices (EPI) will serve as a measure of building performance with respect to energy consumption.

(4) "Life-cycle costs" means the cost of owning, operating, and maintaining the facility over the life of the structure. This may be expressed as an annual cost for each year of the facility's use.

§255.254—No facility constructed or leased withou life-cycle costs

No state agency shall lease, construct, or have con structed, within limits prescribed herein, a facility withou having secured from the division a proper evaluation of life cycle costs, as computed by a qualified architect or engineer Furthermore, construction shall proceed only upon disclos ing, for the facility chosen, the life-cycle costs as determinec in §255.255 and the capitalization of the initial constructior costs of the building. The life-cycle costs shall be a primary consideration in the selection of a building design. Such analysis shall be required only for construction of buildings with an area of 5,000 square feet or greater. For leased areas of 20,000 square feet or greater within a given building boundary, a life-cycle analysis shall be performed and a lease shall only be made where there is a showing that the life-cycle costs are minimal compared to available like facilities.

An Ordinance requiring the City Purchasing Agent to prescribe such rules and procedures as may be necessary to encourage and, where circumstances permit, require the use of life cycle costing as the general basis for City procurement decisions:

The City of Portland ordains:

Section 1. The Council finds:

1. Current City procurement policies tend to overemphasize the initial purchase price rather than the total long-run cost of an item to the City;

2. The cost of energy is a significant portion of the total long-run cost of an item;

3. In the procurement of equipment and materials for the City, evaluation of the long-range potential for energy savings in addition to the initial cost will help promote a reduction in energy consumption as well as dollar savings.

NOW, THEREFORE, the Council directs:

a. The City Purchasing Agent shall promulgate such rules, regulations and procedures as may be necessary to encourage and, where circumstances permit, to require procurement by any board, officer or agent of the City to be done on the basis of the lowest life cycle cost for all items.

   (1) "Life cycle cost" means the total cost of an item to the City over its estimated useful life, including costs of selection, acquisition, operation, maintenance, and where applicable, disposal, as far as these costs can reasonably be determined, minus the salvage value at the end of its estimated useful life.

   (2) The "estimated useful life" of an item means the estimated time from the date of acquisition to the date of replacement or disposal, determined in any reasonable manner.

*/b. In considering bids for purchase, construction or lease, the City Purchasing Agent shall give first consideration to the bid with the lowest life cycle cost which complies with specifications./

*This paragraph may be omitted entirely or added as paragraph (f) to section 5.32.050 (when advertising for bids and written contract required).

18-4-303. Competitive sealed bidding. (1) An invitation for bids must be issued and must include a purchase description and conditions applicable to the procurement.

(2) Adequate public notice of the invitation for bids must be given a reasonable time prior to the date set forth therein for the opening of bids, in accordance with rules adopted by the department. Notice may include publication in a newspaper of general circulation at a reasonable time prior to bid opening.

(3) Bids must be opened publicly in the presence of one or more witnesses at the time and place designated in the invitation for bids. Each bidder has the right to be present, either in person or by agent, when the bids are opened and has the right to examine and inspect all bids. The amount of each bid and such other relevant information as may be specified by rule, together with the name of each bidder, must be recorded. The record must be open to public inspection. After the time of award, all bids and bid documents must be open to public inspection in accordance with the provisions of 2-6-102.

(4) Bids must be unconditionally accepted without alteration or correction, except as authorized in this chapter. Bids must be evaluated based on the requirements set forth in the invitation for bids, which may include criteria to determine acceptability, such as inspection, testing, quality, workmanship, delivery, and suitability for a particular purpose. Those criteria that will affect the bid price and be considered in evaluation for award must be objectively measurable, such as discounts, transportation costs, and total or life-cycle costs. The invitation for bids shall set forth the evaluation criteria to be used. Only criteria set forth in the invitation for bids may be used in bid evaluation.

(5) Correction or withdrawal of inadvertently erroneous bids, before or after award, or cancellation of awards or contracts based on such bid mistakes may be permitted in accordance with rules adopted by the department. After bid opening no changes in bid prices or other provisions of bids prejudicial to the interest of the state or fair competition may be permitted. Except as otherwise provided by rule, all decisions to permit the correction or withdrawal of bids or to cancel awards or contracts based on bid mistakes must be supported by a written determination made by the department.

(6) The contract must be awarded with reasonable promptness by written notice to the lowest responsible and responsive bidder whose bid meets the requirements and criteria set forth in the invitation for bids, including the preferences established by Title 18, chapter 1, part 1. If all bids exceed available funds as certified by the appropriate fiscal officer and the low responsive and responsible bid does not exceed such funds by more than 5%, the director or the head of a purchasing agency is authorized, in situations where time or economic considerations preclude resolicitation of a reduced scope, to negotiate an adjustment of the bid price, including changes in the bid requirements, with the low responsive and responsible bidder in order to bring the bid within the amount of available funds.

(7) When it is considered impractical to initially prepare a purchase description to support an award based on price, an invitation for bids may be issued requesting the submission of unpriced offers, to be followed by an invitation for bids limited to those bidders whose offers have been qualified under the criteria set forth in the first solicitation.

History: En. Sec. 14, Ch. 519, L. 1983.

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